DEEP IN Directed Energy Propulsion for Interstellar Exploration

Completed Technology Project (2015 - 2016)

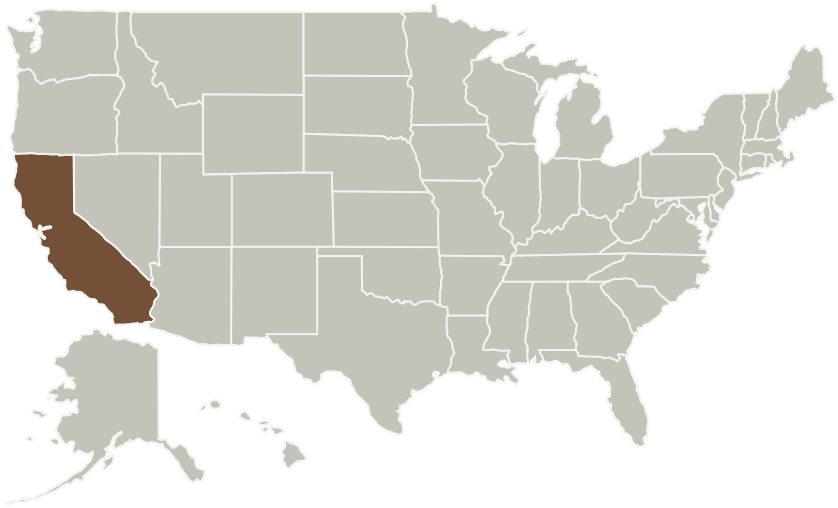
Project Introduction

We will examine a system that will allow us to take a significant step towards interstellar exploration using directed energy propulsion combined with wafer scale spacecraft. One of NASA's goals and one of humanity's grand challenges is to explore other planetary systems by remote sensing, sending probes, and eventually life to explore. This is a long standing and difficult to implement dream. The technological challenges are formidable. A step in this direction is to send small probes that will supplement the current long range remote sensing done by orbital telescopes.

Anticipated Benefits

As we outline in our papers the same basic system can be used for many purposes including both stand-on and stand-off planetary defense from virtually all threats with rapid response, orbital debris mitigation, orbital boosting from LEO to GEO for example, future ground to LEO laser assisted launchers, standoff composition analysis of distant object through molecular line absorption, active illumination of asteroids and other solar system bodies, beamed power to distant spacecraft among others. The same system can also be used for beaming power down to the Earth via micro or mm waves for selected applications. This technology will give us transformative options that are not possible now and allows us to go far beyond our existing chemical propulsion systems.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
University of California-Santa Barbara(UCSB)	Lead Organization	Academia	Santa Barbara, California

Primary U.S. Work Locations
California

Project Transitions

July 2015: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of California-Santa Barbara (UCSB)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

Eric A Eberly

Principal Investigator:

Philip M Lubin

Co-Investigators:

John J Bowers
Forrest D Brewer
Peter R Meinhold
Mark K Pryor
Gary D Hughes

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June 2016: Closed out

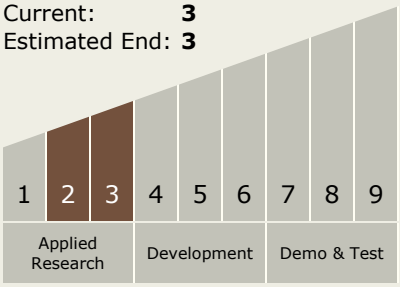
Closeout Summary: In the nearly 60 years of spaceflight we have accomplished wonderful feats of exploration that have shown the incredible spirit of the human drive to explore and understand our universe. Yet in those 60 years we have barely left our solar system with the Voyager 1 spacecraft launched in 1977 finally leaving the solar system after 37 years of flight at a speed of 17 km/s or less than 0.006% the speed of light. As remarkable as this is we will never reach even the nearest stars with our current propulsion technology in even 10 millennium. We have to radically rethink our strategy or give up our dreams of reaching the stars, or wait for technology that does not currently exist. While we all dream of human spaceflight to the stars in a way romanticized in books and movies, it is not within our power to do so, nor it is clear that this is the path we should choose. We posit a technological path forward, that while not simple, it is within our technological reach. We propose a roadmap to a program that will lead to sending relativistic probes to the nearest stars and will open up a vast array of possibilities of flight both within our solar system and far beyond. Spacecraft from gram level complete spacecraft on a wafer (wafersats) that reach more than \xbcc and reach the nearest star in 20 years to spacecraft with masses more than 105 kg (100 tons) that can reach speeds of greater than 1000 km/s. These systems can be propelled to speeds currently unimaginable with existing propulsion technologies. To do so requires a fundamental change in our thinking of both propulsion and in many cases what a spacecraft is. In addition to larger spacecraft, some capable of transporting humans, we consider functional spacecraft on a wafer, including integrated optical communications, imaging systems, photon thrusters, power and sensors combined with directed energy propulsion. The costs can be amortized over a very large number of missions beyond relativistic spacecraft as such planetary defense, beamed energy for distant spacecraft, sending power back to Earth, stand-off composition analysis of solar system targets, long range laser communications, SETI searches and even terra forming. The human factor of exploring the nearest stars and exo-planets would be a profound voyage for humanity, one whose non-scientific implications would be enormous. It is time to begin this inevitable journey far beyond our home.

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.4 Advanced Propulsion
    - TX01.4.4 Other Advanced Propulsion Approaches

Target Destination

Foundational Knowledge